Classifications of the Host Galaxies of Supernovae, Set II

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ABSTRACT

Classifications on the DDO system are given for an additional 231 host galaxies of supernovae that have been discovered during the course of the Lick Observatory Supernova Search with the Katzman Automatic Imaging Telescope (KAIT). This brings the total number of hosts of supernovae discovered (or independently rediscovered) by KAIT, which have so far been classified on a homogeneous system, to 408. The probability that SNe Ia and SNe II have a different distribution of host galaxy Hubble types is found to be 99.7%. A significant difference is also found between the distributions of the host galaxies of SNe Ia and of SNe Ibc (defined here to include SNe Ib, Ib/c, and Ic). However, no significant difference is detected between the frequency distributions of the host galaxies of SNe II and SNe IIn. This suggests that SNe IIn are generally not SNe Ia embedded in circumstellar material that are masquerading as SNe II. Furthermore, no significant difference is found between the distribution of the Hubble types of the hosts of SNe Ibc and of SNe II. Additionally, SNe II-P and SNe II-L are found to occur among similar stellar populations. The ratio of the number of SNe Ia-pec to normal SNe Ia appears to be higher in early-type galaxies than it is in galaxies of later morphological types. This suggests that the ancestors of SNe Ia-pec may differ systematically in age or composition from the progenitors of normal SNe Ia. Unexpectedly, five SNe of Types Ib/c, II, and IIn (all of which are thought to have massive progenitors) are found in host galaxies that are nominally classified as types E and S0. However, in each case the galaxy classification is uncertain, or newly inspected images show evidence suggesting a later classification. Among these five objects NGC 3720, the host galaxy of SN 2002at, was apparently misidentified in the Carnegie Atlas of Galaxies.

Subject headings: supernovae – statistics: galaxies – classification

1. Introduction

Archaeologists derive much of their knowledge of ancient civilizations from digging in ancient cemeteries. By the same token astronomers can learn a great deal about the evolutionary history of galaxies from the frequency, and distribution of, supernova (SN) outbursts which signal the occurrence of stellar deaths.

Until quite recently the discovery of a supernova was a rather rare and haphazard event. However, the advent of modern systematic and automated searches now enables us to study the occurrence of supernovae (SNe) in a much more systematic fashion. The largest such automated search program is currently the Lick Observatory Supernova Search (LOSS) with the 0.75-m Katzman Automatic Imaging Telescope (KAIT). LOSS, which started in 1997 and recently expanded to the Lick Observatory and Tenagra Observatory Supernova Searches (LOTOSS; Schwartz et al. 2000), has been described by Treffers et al. (1997), Li et al. (2000), Filippenko et al. (2001), and Filippenko (2003). In order to derive the full benefit from LOSS, one needs to know both the spectroscopic types of all of these automatically discovered SNe and the morphological classifications of the SN host galaxies. By combining the new morphological classifications of 231 host galaxies with those of 177 hosts in a previous paper, we now have available morphological types for the host galaxies for a total of 408 SNe that were discovered (or independently rediscovered) during the course of the LOSS/LOTOSS surveys. This large and homogeneous data set will be discussed below.

2. New Morphological Classifications

The present investigation represents a continuation of the work of van den Bergh, Li, & Filippenko (2002, hereafter Paper I), in which the Hubble types of 177 SNe discovered during the course of LOSS were classified on the DDO System (van den Bergh 1960a,b,c). In the DDO system galaxies are assigned a Hubble type [E0...E7, S0, Sa, Sb, Sc, Ir], a luminosity class [I...V], and to a form family [S, S(B) or SB]. An "n" denotes smooth-armed spirals, a "*" denotes patchy-armed spirals, a "t" denotes tidally distorted objects, and a ":" is used for uncertain values.

New classifications of the host galaxies of SNe that were discovered (or rediscovered) during the course of LOSS/LOTOSS are listed in Table I. For brevity, in the table N = NGC, I = IC, U = UGC, and M = MCG. In addition to the KAIT CCD images themselves, we also had available either the red images of the Palomar Sky Survey (POSS), or the SERC-J survey in blue-green light. For southern galaxies red IIIaF + RG610 images were also available from the UK Schmidt Equatorial Red Survey or from the UK Schmidt Second Epoch red survey. For additional information on the observational database the reader is referred to Paper I. For some galaxies only images in red light were available. This posed

no problem for elliptical galaxies, but required some "mental extrapolation" for the spirals that had no B images available. All morphological classifications were made by one of the authors (SvdB). Because of the limited dynamic range of the images it was often not possible to distinguish with confidence between E and S0 galaxies. Although the majority of galaxies with redshift $z \approx 0.0$ fit comfortably within the Hubble classification system, there are some that do not. No attempt was made to shoe-horn peculiar objects into the Hubble scheme.

3. Classifications of Galaxy Morphology and Supernova Type

3.1. Luminosity Classifications

Table 1 contains classifications on the DDO system for 44 galaxies that had also been classified previously by van den Bergh (1960c). One of these objects (NGC 4653) was apparently misidentified in that paper and has been excluded from the comparisons given below. For the remaining 24 galaxies that had luminosity classifications the mean difference (in the sense old minus new) was -0.02 ± 0.09 luminosity classes. The root-mean-square dispersion in the difference between the old and the new classifications was 0.43 luminosity classes, so that the intrinsic dispersion of a single luminosity classification on the DDO system is $\sim$0.3 luminosity class. This close agreement is particularly pleasing because our comparison includes objects with uncertain luminosity classifications (that had been marked ":").

3.2. Classifications of Hubble Types

Of the host galaxies of SNe that are listed in Table 1, 36 were also assigned Hubble types by van den Bergh (1960c). Thirty galaxies (83%) were independently assigned the same Hubble type in 1960 and in 2003, 4 (11%) were classified half a Hubble class later in the 2003 investigation, and 2 (6%) were assigned half a Hubble class earlier in the 2003 classification. For no object did the 1960 and the 2003 classifications differ by 1.0 or more Hubble classes. It is remarkable (and satisfying!) to see that morphological classifications made independently (but by the same person) with a time separation of over four decades exhibit no measurable systematic differences.

3.3. Spectral Classifications

The classifications of SN spectra that are given in Table 1 were drawn from the IAU Circulars. Supernovae of Type Ia were divided into "normal" and "peculiar" categories

on the basis of careful inspection of the spectroscopic information in the IAU Circulars: objects that showed the strong Si II λ5970 feature or Ti II absorption lines near 4200 Å (which are evidence for a subluminous SN 1991bg-like event; Filippenko 1997), or weak Si II λ6350 absorption or strong Fe III absorption (which indicates a possibly overluminous, SN 1991T-like event; Filippenko 1997) were classified as "peculiar" SNe Ia.

4. Discussion

4.1. Possible Massive Supernovae in E and S0 Galaxies

It is generally believed (e.g., van den Bergh & Tammann 1991) that only SNe of Type Ia occur among the old stellar populations that inhabit elliptical galaxies. The greatly enlarged modern database of accurate DDO morphological classifications and uniform SN classifications provided in the present paper, and in Paper I, allows us to test this hypothesis.

Table 2 lists the five SNe, which are not of Type Ia, that have been discovered in host galaxies that appear to be of types E or S0. It should be emphasized that late-type galaxies of unusually high surface brightness may be misclassified as being of early type. A good example of this effect is provided by the high surface brightness face-on late-type spiral NGC 3928 = Markarian 190 (van den Bergh 1980) which was misclassified as an E0 in the Second Reference Catalogue (de Vaucouleurs, de Vaucouleurs, & Corwin 1976). It would be of interest to obtain large-scale images of the galaxies that are listed in Table 2 to see if any of these galaxies were misclassified, or show evidence for a recent merger with an object of later type that might have contained massive stars. Alternatively, a few early-type galaxies with late-type companions might have picked up some gas during tidal encounters. In this connection it is noted that Sandage & Bedke (1994) refer to very subtle dust patches in NGC 2768. Massive stars and SN progenitors might, of course, also have formed recently in the gas that was so acquired. Finally, some of the SNe II that appear to be located in E or S0 galaxies might actually be situated in dim late-type companions to these objects.

On the basis of the data listed in Table 2 it appears that not more than $\sim$3% of all SNe with massive progenitors occur in E and S0 galaxies. However, note that some of our E/S0 classifications might be erroneous because the SN host galaxy was a late-type object with an unusually high surface brightness. Such a high surface brightness might, for example, result from an intense burst of star formation triggered by a rather recent tidal encounter. As listed in the notes of Table 2, out of the 5 galaxies mentioned, two (UGC 2836 and NGC 3720) are possible Sa galaxies, and two (IC 2461 and IC 3203) are viewed edge-on and have somewhat uncertain classifications (note, for example, NED[1] lists the two galaxies as Sb

[1]NED is the NASA/IPAC Extragalactic Database, http://nedwww.ipac.caltech.edu.

and Sbc, respectively). Even NGC 2768 might not be a convincing early-type galaxy, being classified as E3/Sa; moreover, it is a LINER and may host a nuclear starburst. It is thus inconclusive whether *any* SNe with massive progenitors have been discovered in normal early-type (E/S0) galaxies from this study.

4.2. Relative Supernova Numbers in Galaxies of Differing Types

The number of SNe of various types in Table 1 is listed in Table 3. In Table 4 these new data are combined with those that we had previously published in Paper I. Inspection of these data reveals the following trends:

1. A Kolmogorov-Smirnov test shows that the distribution of 117 SNe Ia and 119 SNe II (excluding SNe IIn) over host galaxy type is different at 99.7% confidence. The observed difference is in the expected sense, with the SNe II (which are believed to have massive core-collapse progenitors) being most common in late-type galaxies of Hubble types Sb–Sc, whereas SNe Ia are observed to occur in hosts of all Hubble types. A small number of possible cases in which SNe II appear to have occurred in environments that seem to be overwhelmingly composed of old stars is given in Table 2. Note, however, that such objects account for only $\sim$3% of our total sample of core-collapse SNe (i.e., SNe II, Ib, Ib/c, Ic).

2. A comparison between the distributions of 119 SNe II and of 15.5 SNe IIn shows no hint of any difference in the distribution of host types for these two kinds of SNe, but this result suffers from small-number statistics (an object classified as S0/Sa was counted as 0.5 S0 and 0.5 Sa). In this connection it is noted that Hamuy et al. (2003) have recently speculated that some SNe IIn might be SNe Ia that are interacting with circumstellar material. If our conclusion is correct, most SNe IIn are probably *not* SNe Ia masquerading as SNe II. Only if SNe IIn come from the subset of SNe Ia having the most massive possible progenitors could the two observed distributions be consistent.

3. A comparison between the distributions of normal and peculiar SNe Ia hints at the possibility that SNe Ia-pec might occur preferentially in early-type hosts. A Kolmogorov-Smirnov test shows that there is only a 7% probability that they are drawn from the same parent population of host galaxies. Since some normal SNe Ia and SNe Ia-pec occurred in S0 galaxies, which lie outside the linear E-Sa-Sab-Sb-Sbc-Sc-Ir scheme, the sample can be enlarged by dividing galaxies into (1) elliptical and S0 galaxies, and (2) spiral and irregular galaxies. Such a division has the advantage that it allows us to include in the statistics spirals classified as "S" but that could not be assigned to types "Sa," "Sb," or "Sc." Table 5 shows a compilation of the frequency distribution of normal SNe Ia and SNe Ia-pec in E + S0 galaxies and in

S + Ir galaxies. For the data in this table, $\chi^2 = 4.7$. A χ^2 test with one degree of freedom therefore yields only a 3% chance that SNe Ia-pec have the same probability distribution over Hubble types as do normal SNe Ia.

4. There is not even a hint of a difference in the distribution of host-galaxy Hubble types between 45.5 SNe Ibc (defined here to include SNe Ib, Ib/c, and Ic) and 119 SNe II. Moreover, although the currently available data sample is rather small, there is no evidence that SNe Ib, SNe Ib/c, and SNe Ic have different distributions over host-galaxy types.

5. A Kolmogorov-Smirnov test of the data for 117 SNe Ia and 46.5 SNe Ibc shows that there is only a 0.1% probability that the host galaxies of these two types of objects are drawn from the same distribution of Hubble types.

These results are consistent with the widely held suspicion that SNe Ib, SNe Ib/c, SNe Ic, and SNe II all have massive progenitors, whereas those of SNe Ia do not.

4.3. Peculiar Type Ia Supernovae

The data in Table 1 show that the majority of the 16 SNe Ia with spectra resembling that of the peculiar, subluminous SN 1991bg occurred in early-type galaxies, whereas all three of those with spectra like the peculiar, possibly overluminous SN 1991T erupted in spirals of types Sb or Sc. A Kolmogorov-Smirnov test shows that there is only a 4% probability that objects like SN 1991bg and those resembling SN 1991T are drawn from the same distribution of host galaxy classification types. Our results suggest that luminous SNe Ia resembling SN 1991T probably had younger (or more massive) progenitors than do those of the SN 1991bg variety. The present data confirm and strengthen a similar conclusion by Howell (2001).

4.4. Supernovae of Types II-L and II-P

Ever since Minkowski (1941), it has been customary to classify SNe primarily according to their spectra. However, it is also possible to classify them from their light-curve morphology. This enables one to assign SNe II to "L" (linear) and "P" (plateau) subtypes (e.g., Doggett & Branch 1985). Schlegel (1996) and Filippenko (1997) have suggested that SNe II-P and SNe II-L can be spectroscopically distinguished on the basis of the presence or absence of Hα absorption. However, this speculation still needs to be confirmed with additional data.

A recent listing of SNe II that have been assigned to the linear and plateau subtypes is given in the Asiago Supernova Catalog (http://merlino.pd.astro.it/∼supern/). For the

majority of these objects, high quality and homogeneous morphological classifications of the host galaxies, based on inspection of plates obtained with large reflectors, are given by Sandage & Tammann (1981). These data show a very similar distribution of SNe II-L and of SNe II-P over Hubble types. It is found that 17 out of 25 (68%) of all SNe II-P occur in galaxies of type Sc. This does not differ significantly from the distribution of SNe II-L, for which 8 out of 11 (73%) are located in spirals of type Sc. Luminosity classes are available for only 34 of the host galaxies of SNe assigned to types II-P and II-L. For this small sample there is a hint that SNe II-L might occur in more luminous (metal-rich?) galaxies than do SNe II-P. However, a Kolmogorov-Smirnov test of the data shows that this possible difference does not have a respectable level of statistical significance. It is therefore concluded that the currently available database does not provide evidence for a significant difference between the host populations of SNe II-P and SNe II-L.

5. Summary

Morphological types on the DDO system are now available for a homogeneous sample of the host galaxies of 408 SNe that were discovered (or rediscovered independently) during the course of the LOSS/LOTOSS surveys. Based on these data, we come to the following conclusions.

1. The present (2003) classifications of Hubble types and luminosity classes by van den Bergh are, to within statistical errors, found to be on exactly the same system as his DDO classifications that were made in 1959 and 1960.

2. Five SNe of Types Ib/c, II, and IIn (which are thought to have massive progenitors) are found to have occurred in host galaxies nominally classified as types E or S0. However, in each case the galaxy classification is uncertain, or newly inspected images show evidence suggesting a later classification. Thus, we find no clear evidence of SNe with massive progenitors occurring in E or S0 galaxies. It would clearly be important to obtain new, large-scale images of the five early-type galaxies to improve the classifications and to search for possible evidence of young population components.

3. The distribution of SNe Ia and SNe Ia-pec over host-galaxy Hubble types is found to differ from that for SNe II + SNe IIn at 99.7% confidence.

4. No statistically significant differences are found between the distributions over Hubble type of the host galaxies of SNe II and SNe IIn. Hence, it appears unlikely that most SNe IIn are actually SNe Ia embedded in circumstellar material.

5. Compared with normal SNe Ia, those objects classified as SNe Ia-pec are found to be more common in early-type galaxies than they are in spirals of later type. A Kolmogorov-Smirnov test shows only a 1.6% probability that the 117 SNe Ia and the

29.5 SNe Ia-pec in Table 4 are drawn from the same parent population of Hubble types. This suggests that the progenitors of normal SNe Ia may differ in age or metallicity from the ancestors of SNe Ia-pec.

6. Among SNe Ia-pec, those that resemble SN 1991T appear to be younger (or more massive) than those like SN 1991bg — i.e., all three SN 1991T-like objects occurred in spirals of types Sb to Sc, whereas 14 out of 16 objects resembling SN 1991bg were hosted by galaxies of type E, S0, or Sa. A Kolmogorov-Smirnov test shows only a 1.4% probability that the three SN 1991T-like and the sixteen SN 1991bg-like objects are drawn from the same population of host galaxy Hubble types.

7. There is only a 0.1% probability that the SNe Ia and SNe Ibc (defined here to include SNe Ib, Ib/c, and Ic) in the present sample are drawn from the same parent population. SNe Ia are found to occur in all kinds of galaxies, whereas the (presumably more massive) progenitors of SNe Ibc mostly occur in spirals of types Sb–Sc.

8. No significant differences are found between the distributions over Hubble type of the small numbers of SNe Ib, SNe Ib/c, and SNe Ic contained in the present sample.

9. SNe II-P and SNe II-L appear to occur in galaxies having similar stellar populations.

All of the data discussed above refer to the relative rates of SNe of different types. The implications of the present morphological classifications for absolute frequency determinations of SNe of different types will be the subject of a future investigation.

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Table 1. Classifications of SN Host Galaxies

Note:—Remarks: (1) merger; (2) edge-on; (3) tides; (4) compact, high surface brightness; (5) ring; (6) in a compact cluster; (7) galaxy too faint to classify; (8) SN 2003A is probably in the Sb galaxy U5904, even though it is closer to the E4 galaxy U5907; (9) SN 2003H occurs halfway between two Sc galaxies, either of which could be the host galaxy; (10) possibly two nuclei.

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
1998dl	N1084	Sc II:	II	1406	
1998dn	N 337A	Sc pec	II	1094	
1998ec	U3576	SBb	Ia	5966	
1998ey	N7080	S(B)bc I	Ic-pec	4839	
1999D	N3690	S + Pec	II	3121	
1999aa	N2595	S(B?)bc pec II:	Ia-pec (91T)	4330	
1999an	I 755	Sb: III-IV	II	1507	2
1999di	N 776	S(B)bc I-II	Ib	4921	
1999dn	N7714	Stt	Ib/c	2798	3
1999eh	N2770	Sbc: III-IV?	Ib	1947	
1999el	N6951	S(B)b I-II	IIn	1424	
1999ev	N4274	Sab II-III	II	930	
1999gi	N3184	Sc I	II	592	
1999gk	N4653	Sc II:	II	2626	
1999gn	N4303	Sc I	II	1566	
2000B	N2320	S0/E3	Ia	5944	
2000C	N2415	?	Ic	3784	4
2000E	N6951	SBb I-II	Ia	1424	
2000K	M+09-19-191	E2	Ia	16000	
2000L	U5520	Sb II-III:	II	3315	
2000M	N6389	Sbc II	II	3119	
2000bk	N4520	E3/Sa	Ia	7628	
2000ce	U4195	SBb II	Ia	4888	
2000cr	N5395	Sbt I?	Ic	3491	
2000cs	M+07-34-15	Sab	II	10532	
2000cz	I1535	Sb III-IV	II	5231	
2000db	N3949	Sbc III:	II	800	
2000ds	N2768	E3/Sa	Ib/c	1373	

Table 1. (continued)

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2000ew	N3810	Sc I-II	Ic	993	
2000ez	N3995	Sc? t	II	3254	
2000fn	N2526	Sa	Ib	4603	
2000fs	N1218	E2	Ia	8590	
2000ft	N7469	Sb: pec	?	4892	
2000fu	M-03-38-21	S(B?)b:	?	3265	
2000fv	M-04-35-11	SBab	?	2738	
2001H	M-01-10-19	Sb II	II	5248	
2001K	I 677	Sab:	II	3249	
2001T	M-02-37-6	Sb II-III:	II	4167	
2001V	N3987	Sb I?	Ia-pec (91T)	4502	2
2001X	N5921	SBb I	IIp	1480	
2001aa	U10888	SBb I-II	II	6110	
2001ad	N6373	Sc pec	IIb	3320	
2001bg	N2608	Sc II:	Ia	2135	
2001bq	N5534	Sb: t	II	2633	
2001br	U11260	SBb II-III:	Ia	6184	
2001cf	U7020	Sbc I-II	IIb	6132	
2001cm	N5965	Sb	II	3412	2
2001dc	N5777	Sb	II-pec	2145	2
2001de	U12089	Sbc	Ia-pec (91bg)	9313	
2001dn	N 662	Ir?	Ia	5654	
2001dp	N3953	S(B)bc I	Ia	1052	
2001dr	N4932	S(B?)c II	II	7088	
2001dw	N1168	S(B)b II	Ia	7627	
2001dz	U 471	Sc II:	II	14810	
2001eb	N1589	Sab	Ia	3793	2
2001ed	N 706	Sc II-III:	Ia	4980	
2001ee	N2347	Sb III	II	4421	
2001eg	U3885	Sbc III:	Ia	3809	
2001ej	U3829	St + S?	Ib	4031	1?
2001eo	U3963	Sb III-IV:	Ia	...	2
2001ew	...	E2/Sa	Ia	...	
2001ex	U3595	SBbc II	Ia	7908	
2001fe	U5129	Sa	Ia	4059	
2001fv	N3512	Sc II-III	II	1376	
2001fz	N2280	Sb I-II	II	1906	
2001gd	N5033	Sbc II	IIb	875	
2001hg	N4162	Sc II	II	2569	
2001ib	N7242	E2	Ia-pec (91bg)	5790	
2002an	N2575	Sbc III	II	3870	

Table 1. (continued)

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2002ap	N 628	Sc I	Ib/c-pec	657	
2002at	N3720	E1	II	5985	
2002au	U5100	SBbc II-III:	Ia	5514	
2002av	ESO 489-G7	E0 pec	Ia	...	5?
2002aw	...	Sb/S0	Ia	...	2
2002bf	CGCG 266-031	Sa	Ia	7254	
2002bg	M+02-38-31	Sbc II	Ia	12814	
2002bh	U5286	Sc II-III	II	5198	
2002bi	U8527	S	Ia	6986	2
2002bj	N1821	Sc:	IIn	3608	
2002bl	U5499	Sb III:	Ib/c-pec	4753	
2002bm	M-01-32-19	SBbc I	Ic	5462	
2002bo	N3190	Sa III	Ia	1271	2
2002bp	U6332	Sa:	?	6227	5
2002bs	I4221	Sc	Ia	2895	
2002bt	U8584	St+E+S	Ia	17859	1
2002bu	N4242	S/Ir IV	IIn	517	
2002bv	U4042	SBb II-III	IIn	8292	
2002bw	...	S?	Ia	5197	
2002bx	I2461	S0	II	2260	2
2002bz	M+05-34-33	E1	Ia	11090	
2002ca	U8521	SBb: II-III	II	3277	
2002cc	...	Sab	Ia	19950	
2002cd	N6916	Sc:	Ia	3101	
2002ce	N2604	SB IV?	II	2094	
2002cf	N4786	E2	Ia-pec (91bg)	4647	
2002cg	U10415	Sc I-II:	Ic	9546	
2002ci	U10301	S(B?) III:	Ia	6663	
2002cj	ESO 582-G5	Sb	Ic	6758	
2002ck	U10030	SBb III	Ia	8953	
2002cp	N3074	Sc I-II	Ib/c	5144	
2002cr	N5468	Sc II	Ia	2845	
2002cs	N6702	E2	Ia	4728	
2002cu	N6575	E2	Ia-pec (91bg)	6992	
2002cv	N3190	Sab t	Ia	1271	2
2002cw	N6700	SBbc II-III	Ib	4588	
2002cy	N1762	Sab:	?	4753	
2002db	N5683	Sa:	Ia	10859	
2002de	N6104	SB IV	Ia	8428	
2002df	M-01-53-6	S(B)b II:	Ia	...	
2002di	M+05-40-2	Sa:	Ia-pec (91bg)	10910	

Table 1. (continued)

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2002dj	N5018	E2/Sa pec	Ia	2794	
2002dk	N6616	Sa t	Ia-pec (91bg)	5556	2
2002dl	U11994	S IV	Ia-pec (91bg)	4872	2
2002dn	I5145	Sab	Ic	7355	
2002do	M+07-41-1	E2	Ia-pec (91bg)	4761	
2002dp	N7678	Sc pec II:	Ia	3489	
2002dq	N7051	S(B?)ab II	II	2519	
2002dr	U12214	E3	Ia	6610	
2002ds	ESO 581-G25	S IV	II	2277	2
2002dt	ESO 516-G5	Sc I-II	Ib/c?	7487	
2002dv	U11486	S pec	II	7923	
2002dw	U11376	Merger	II	6528	
2002dx	U12861	Sa	Ia	7100	
2002dy	M-01-59-24	Sc	II	9904	
2002dz	M-01-1-52	S III-IV:	Ib/c	5361	
2002ea	N 820	Sa	IIn	4418	
2002eb	CGCG 473-011	Sa:	Ia	8255	
2002ec	N5910	E0 (t?)	Ia	11976	
2002ed	N5468	Sc I-II	II	2845	
2002ee	N5772	Sa	II	4900	
2002ef	N7761	E0	Ia	7080	
2002eg	U11486	S pec	IIb	7923	
2002eh	N 917	Sa	Ia	5388	
2002ei	M-01-09-024	S IV	II	2319	
2002el	N6986	E3	Ia	9000	
2002em	U3430	Sab:	II	4059	2
2002en	U12289	S	II	10163	
2002eo	N 710	Sc: III-IV:	II	6132	
2002er	U10743	Sab III-IV:	Ia	2569	2
2002es	U2708	E1/Sa	Ia-pec (91bg)	5394	
2002et	M-04-47-10	Sb II	Ia	8217	
2002eu	...	S0/Sa	Ia-pec (91bg)	11280	
2002ey	...	E2/S0	Ia-pec (91bg)	...	
2002fb	N 759	E1	Ia-pec (91bg)	4667	
2002fi	M-04-7-10	SBb II-III	Ia	17138	
2002fj	N2642	SBbc I	IIn	4342	
2002gc	U1394	Sb III-IV:	Ia-pec (91bg)	6388	
2002gd	N7537	Sab III:	II	2674	
2002gw	N 922	S(B)c: III:	II	3092	
2002gy	U2701	Sbc IV	Ib/c	7285	2
2002ha	N6962	Sbc II	Ia	4211	

Table 1. (continued)

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2002hc	N2559	Sc: pec	II	1561	
2002hd	M-01-23-8	E3	Ia	10500	
2002he	U4322	E2	Ia-pec (91bg)	7384	
2002hf	M-05-3-20	Sab II:	Ic	5609	
2002hg	N3306	Sb: III-IV:	II	2889	
2002hh	N6946	Sc I	II	48	
2002hi	...	?	IIn	18000	7
2002hk	M-07-15-6	S(B:)ab III	II	5751	
2002hl	N3665	E1	Ia	2080	
2002hm	N4016	S(B?) pec	II	3448	
2002hn	N2532	Sc II-III:	Ic	5260	
2002ho	N4210	SBbc II	Ic	2732	
2002hv	U4974	E0	Ia	7023	
2002hw	U 52	Sa	Ia	5257	
2002hx	...	SBbc II	II	9293	
2002hy	N3464	Sb II	Ib	3729	
2002hz	U12044	Sb/S0	Ib/c	5444	
2002je	...	S pec	II	...	
2002jg	N7253	Ir/Pec t	Ia	4718	
2002ji	N3655	S pec	Ib/c	1473	
2002jj	I 340	S pec?	Ic	4218	10
2002jm	I 603	Sa	Ia-pec (91bg)	5400	5
2002jo	N5708	S pec	Ia	2751	
2002jp	N3313	SBb I	Ic	3706	
2002jy	N 477	S(B)c II:	Ia	5876	
2002jz	U2984	Pec	Ic	1543	
2002ka	...	E1/S0	Ia	2062	
2003A	U5904	Sb	Ib/c	6591	2,8
2003C	U 439	Sa pec	II	5302	
2003D	M-01-25-9	E3	Ia-pec (91bg)	6628	6
2003E	M-04-12-4	Sc	II	4409	2
2003F	U3261	Sc	Ia	5169	
2003G	I 208	Sa	IIn	3449	
2003H	N2207	Sc I-II: t + St	Ib	2741	9
2003I	I2481	Sab	Ib	5322	
2003J	N4157	Sb III	II	774	2
2003K	I1129	Sc	Ia	6540	
2003L	N3506	Sc III:	Ic	6403	
2003M	U7224	?	Ia	7267	7
2003O	U2798	S(B)b III-IV	II	4941	
2003S	M+09-22-94	S	Ia	11700	2

Table 1. (continued)

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2003T	U4864	S pec	II	8268	
2003U	N6365	Sbn:	Ia	8496	
2003W	U5234	Sc III:	Ia	6017	
2003X	U11151	S0:	Ia	7017	
2003Y	I 522	E1	Ia-pec (91bg)	5079	
2003Z	N2742	Sc II-III	II	1289	
2003aa	N3367	S(B)c I-II	Ia-pec (91T)	3037	
2003ac	I3203	S0:	IIb	6910	2
2003ag	U6440	Sc I	Ia	6777	
2003ah	...	Sb:	Ia	...	2
2003ai	I4062	Sa?	Ia	...	
2003am	ESO 576-G40	S0: t	II	2085	
2003an	M+05-32-22	E1	Ia	11163	
2003ao	N2993	Sn t	II	2420	
2003au	N6095	E0	Ia-pec (91bg)	9243	
2003bk	N4316	Sab III:	II	1252	2
2003bl	N5374	Sc II:	II	4295	
2003bm	U4226	S pec	Ic	7907	
2003bp	N2596	Sb:	Ib/c	5938	
2003bq	U3513	Sb III-IV:	?	7358	
2003br	M-05-34-18	Sb I-II	II	3758	
2003bu	N5393	Sa:	Ic	6019	
2003bw	I1077	Sc II:	II	3452	
2003cg	N3169	Sab III	Ia	1238	
2003ch	U3787	E3	Ia	...	
2003ci	U6212	Sb: II: t	II	9091	
2003cm	U10590	SBbc III:	...	3054	
2003cn	I 849	Sab:	II	5430	
2003cq	N3978	Sbn: pec	Ia	9978	
2003dg	U6934	Sb: III-IV	...	5536	2
2003dl	N5789	S*/Ir	...	1805	
2003dr	N5714	Sbc:	...	2237	2
2003ds	M+08-19-17	?	...	9210	
2003dt	N6962	Sb II t?	Ia	4211	
2003du	U9391	SB/Ir IV:	Ia	1914	
2003dv	U9638	Sc III-IV:	IIn	2271	
2003dw	M+10-24-51	Sb II	Ia	9003	
2003ed	N5303	S?	IIb	1419	4
2003ef	N4708	S pec	II	4103	

Table 2. Massive Supernovae in Possible E and S0 Galaxies

SN	Galaxy	DDO Type	SN Type	Velocity (km/s)	Remarks
2000ds	N2768	E3/Sa	Ib/c	1373	1
2001I	U2836	E2	IIn	4963	2
2002at	N3720	E1	II	5985	3
2002bx	I2461	S0	II	2260	4
2003ac	I3203	S0:	II	6910	5

[1]On the basis of a plate obtained by Walter Baade with the Palomar 200-in telescope, Sandage & Bedke (1994) state that "The definite outer envelope of NGC 2768 surrounding an E6 bulge makes the S0 classification certain."

[2]The presence of this SN IIn in an E galaxy was already noted in Paper I. However, inspection of images at different contrast shows evidence for some substructure in the envelope of this galaxy. An Sa: classification might therefore be more appropriate than the one given in the tables.

[3]Inspection of panel 185 of the Carnegie Atlas of Galaxies (Sandage & Bedke 1994) appears to show an image of NGC 3719, rather than that of NGC 3720, which was the host galaxy of SN 2002at. The morphological classification of NGC 3720 given in A Revised Shapley Ames Catalog of Bright Galaxies (Sandage & Tammann 1981) also appears to refer to NGC 3719. A. Sandage (2003, private communication) informs us us that such an interchange would not have affected the classification given in the Revised Shapley-Ames Catalog because both NGC 3719 and NGC 3720 are assigned to the same classification type. However, our inspection of red and blue images with differing contrast actually shows some structure in the envelope of NGC 3720, suggesting that an Sa: classification would be preferable to the the E1 classification given in our tables.

[4]The classification is somewhat uncertain because this object is viewed edge-on. It might be an edge-on S0 galaxy that contains a dust lane. A blue image shows some clumpiness in the disk, suggesting the presence of a young population component.

[5]The classification is somewhat uncertain because this object is viewed edge-on. Reexamination of this object on images with differing contrast suggests some distortions of the structure. Perhaps S0-pec might therefore have been a more appropriate classification than the S0: classification given in our tables.

Table 3. Galaxy Classification and SN Type: New[a,b]

Galaxy type	Ia	Ia-pec	Ibc[c]	II	IIn
E	14.5	9.5	0	1	0
E/Sa	3	1	1	0	0
Sa	9	4	2	2	2
Sab	5	0	2	9	0
Sb	16.5	1	7.5	19	2
Sbc	6	2	7	6	1
Sc	11	1	8	22	2
Ir	2	0	0	0	0.5

[a]Only new data from Table 1.

[b]Half-integer values refer to intermediate morphologies (e.g., E/Sb is counted as 0.5 E and 0.5 Sb).

[c]Here, the "Ibc" designation includes SNe Ib, Ib/c, and Ic.

Table 4. Galaxy Classification and SN Type: All[a,b]

Galaxy type	Ia	Ia-pec	Ibc[c]	II	IIn
E	21.5	10.5	0	2	1
E/Sa	8	3	1	0	0
Sa	13	5	4	10	2
Sab	9	4	4	11	0
Sb	35.5	3	9.5	36	4
Sbc	11	3	13	18	2
Sc	17	1	15	40	6
Ir	2	0	0	2	0.5

[a]All host galaxies of SNe discovered during LOSS/LOTOSS – i.e., the sum of the data from the present paper and those from Paper I.

[b]Half-integer values refer to intermediate morphologies (e.g., E/Sb is counted as 0.5 E and 0.5 Sb).

[c]Here, the "Ibc" designation includes SNe Ib, Ib/c, and Ic.

Table 5. Frequency of Host Galaxies of Normal SNe Ia and SNe Ia-pec[a]

Host Galaxy Type	Normal SNe Ia	SNe Ia-pec
E + S0 Galaxies	26.5	14
Spirals + Irregulars	101	20

[a]Half-integer values refer to intermediate morphologies (e.g., E/Sb is counted as 0.5 E and 0.5 Sb).